Missouri Department of Natural Resources
Water Pollution Control Program

Total Maximum Daily Load (TMDL)

for

Middle Fork of Tebo Creek
Tributary to Middle Fork of Tebo Creek
West Fork of Tebo Creek
Henry County, Missouri

Submitted: December 10, 2003
Approved : February 12, 2004

Phased Total Maximum Daily Loads (TMDLs)
For Middle Fork, Tributary to Middle Fork and West Fork of Tebo Creek
Pollutants: Sulfate and pH

October 24, 2003

Name: West Fork, Middle Fork, and Tributary to Middle Fork Tebo Creeks

Location: Near Windsor in Henry County, Missouri

Hydrologic Unit Code (HUC): 10290108 (Tebos)

Water Body Identifications (WBID):
- 1284—Middle Fork Tebo Creek
- 1288—Tributary to Middle Fork Tebo Creek
- 1292—West Fork Tebo Creek

Missouri Stream Classifications: All Tebo Creek segments addressed in this TMDL are classified as C[1]

Location of Tebo Creek Watershed

Beneficial Uses for the Tebo Creeks[2]: Livestock and Wildlife Watering and Protection of Warm Water Aquatic Life and Human Health [associated with] Fish Consumption.

Pollutants: Sulfate and pH

Size of Impaired Segments:

1284—Middle Fork Tebo Creek	5.5 miles sulfate
1288—Tributary to Middle Fork Tebo Creek	1.0 mile pH and sulfate, 1.6 miles sulfate
1292—West Fork Tebo Creek	7.0 miles sulfate

The length of impairment in the Tributary to Middle Fork Tebo Creek used for this TMDL is different than the length identified on the 1998 303(d) list. On the 1998 list, the Tributary to Middle Fork Tebo Creek was listed as impaired by both pH and sulfate for 2.0 miles and by sulfate for 1.6 miles. The data collected for the development of this TMDL indicated the length of the impairment for both pH and sulfate was 1.0 miles and the length of the sulfate impairment remained the same, 1.6 miles.

Location of Impaired Segments:

1284—Middle Fork Tebo Creek	from Sec 31, T43, R24W to Sec 7, T43, R24W
1288—Trib. to Middle Fork Tebo	from Sec 7, T43, R24W to Sec 36, T44, R25W
1292—West Fork Tebo Creek	from Sec 24, T42, R25W to Sec 9, T42, R25W

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[1] Class C streams may cease to flow in dry periods but maintain permanent pools that support aquatic life. See 10 CSR 20-7.031(1)(F)

[2] For Beneficial uses see 10 CSR 20-7.031()(C) and Table (H)

Pollutant Sources:

Tebo Creeks: New Castle and Spangler abandoned coal mining areas in Henry County

TMDL Priority Ranking: Low

1.0 Background and Water Quality Problems

The Tebo Creek area has been an important coal-producing site since the 1800's. By 1895, there were numerous underground mines along the Missouri-Kansas-Texas (MKT) railroad near Lewis, Calhoun, and Windsor, Missouri. Between 1942 and the early 1950's, over 1200 acres in this area were strip-mined. Most of this coal was processed and large amounts of coal wastes were deposited in pits in and along the upper portions of Middle Tebo Creek near the Johnson-Henry county line. A smaller coal waste site was located on East Tebo Creek about 1.5 miles northwest of downtown Windsor. When sulfide minerals in rock are exposed to water and oxygen, they oxidize and form very acidic (low pH) and high sulfate drainage, which is harmful to aquatic life. These minerals make up a large amount of the coal wastes in the Tebo Creek area. Acid mine drainage affected both Middle and East Tebo Creeks, and was particularly severe in Middle Tebo Creek due to the large volumes of coal wastes that were continually eroding into the stream. Shales overlaying both the Tebo and Crowesburg coal seams are extremely acid forming, and this resulted in barren spoil and revegetation problems once the areas were abandoned. Acid drainage from the abandoned coal mines represented a significant threat to aquatic resources, not only due to the affects of the low pH, but also from the potential for increased levels of metals such as lead, cadmium, silver, and zinc. Most metals become more bio-available in acidic water. They enter a dissolved state and the negative impact on aquatic life increases.

Mineralized groundwater moving through the spoils produced high levels of sulfate in West Tebo Creek all the way to its confluence with the main stem of Tebo Creek. About 4.5 miles of Middle Tebo Creek were rated as continuously polluted by acid mine drainage with another four miles downstream intermittently affected by slugs of acidic water. The West and Middle Tebo Creek watersheds drain extensive acres of abandoned coal fields and empty into the Tebo arm of the Truman Lake. Truman Lake is recognized as one of the most significant sport fisheries and recreational areas in the Midwest. Historically, leachates from the mining sites have resulted in fish kills, and an acid slurry impoundment was severely eroded and represented an additional source to pollution levels in Truman Lake. Ten major fish kills in Middle Tebo occurred between 1955 and 1988.

Attempts were made to control acid mine drainage by the Windsor Coal Company in 1951 when a circuit court judge ordered precautionary measures be taken to prevent further pollution of Tebo Creek. The company tried to abate the problem by covering areas of exposed gob. This temporarily reduced acid mine drainage, but investigations made by the Missouri Department of Conservation and the Missouri Water Pollution Board in 1961 indicated that the gob slopes were eroding and exposure of acid producing materials had increased acid mine drainage. In 1981, the Missouri Department of Natural Resources retained a consulting firm to investigate the site. Their study indicated acid mine drainage was being produced at the site. In 1988, the department retained another consulting firm to design a reclamation plan.[3]

By 1977, the Abandoned Mine Reclamation Fund had been established as a means to provide funding to recover abandoned coal mine lands in the United States. Using this authority, the Missouri Department of Natural Resources reclaimed the Tebo Creek coal waste areas in the early 1990's. A total of 486 acres were re-graded, covered with soil, and revegetated. On the Middle Tebo site, a wetland was constructed for treatment of acid water and seven grade stabilization structures were placed in the creek to stabilize the stream channel. Projects on the Middle and East Tebo Creeks totaled $4.6 million. The table of recent water quality data (See Tables 1-4, Appendix C) shows that the reclamation projects have been successful in greatly reducing acid water discharge to Middle Tebo creek and have reduced the danger of fish kills in the Tebo arm of Truman Lake. On Middle Tebo Creek there are two miles of acid water and an additional seven miles of highly mineralized water that exceeds the state standard for sulfate. Remaining acidity and sulfate problems presently result from the movement of shallow groundwater through spoils and buried coal wastes and the emergence of these groundwaters into the Tebo Creeks watershed.

The only practical option for additional treatment in the Tebo areas would be to intercept and transport these contaminated groundwaters to a suitable treatment system. Due to the extensive nature of mined lands in this area, many individual treatment systems would be needed. This type of project would be cost prohibitive at this time. Maps of the areas and graphs summarizing the existing data are contained in the appendices at the end of this document.

1.1 Physical Characteristics of Basin

Henry County is located in west central Missouri and is an upland prairie area with gently sloping to steep topography. Streams generally flow from the higher relief in the northwestern part of the county to the lower relief in the southeastern part. Tebo Creek and its tributaries drain into the Osage River, which is now impounded by Truman Dam in neighboring Benton County. Rainfall averages about 39 inches with much of it coming during the growing season. Because the strip-mined areas in the Tebo Creek watershed have been so disrupted and the impacted area is extensive, it is impossible at this point to determine what exact soil types are represented. The Henry County Soil Survey designates the mined areas on their soils maps as "Mine pits and dumps" and describes them as "…steep, irregularly shaped dumps are a mixture of shale, sandstone, and the original mantle of soil stripped from the coal beds." It concludes that these areas' "response to management is poor.[4]" Use of these areas is restricted to grazing, woodland or wildlife habitat.

1.2 Land Use Information in Basin

Uplands in the Tebo Creeks basin are primarily of the Hartwell-Deepwater soil association. These are deep, nearly level to moderately sloping soils. They range from poorly drained to

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[3] Memorandum from Black and Veatch, Engineers-Architects to the Missouri Land Reclamation Commission, 5/23/89.

[4] Soil Survey of Henry County, United States Department of Agriculture Soil Conservation Service, 1976, page 40.

well drained soils formed in thin loess with the underlying minerals derived from acidic shale. Native vegetation is tall grasses; however, these soils are also suited to row crop agriculture and hay production.

Verdigris-Osage soil association is located along Middle Fork and West Fork Tebo Creek. They are deep, nearly level soils found along streams and drainageways. They are fertile, moderately well drained to poorly drained soils formed in alluvium derived from sandstone and shale. This soil association is used for row crops, hay production, and riparian forest. The primary tree species found along the creeks are pecans. Limitation for use of this soil association is wetness and flooding.

The Barco-Coweta soil association is found along the lower portion of West Fork of Tebo Creek. It is moderately deep to shallow soil on sloping to moderately steep ground found along drainageways. These soils are well drained and were formed from sandstone. Permeability is moderate and fertility is low. Sandstone outcrops are common. Native vegetation is warm-season tall grasses. The limitation on the use of this soil association is the susceptibility to erosion.

The Mandeville-Bolivar soil association is found in narrow bands along Middle Fork, Tributary to Middle Fork and West Fork of Tebo Creek. These are moderately deep soils on moderately steep slopes. These well-drained soils are formed from limestone and phosphatic shales and some coal. The native vegetation for this soil association are trees. More level areas are used as farm fields and steeper areas are used for grass or trees. Susceptibility to erosion and excessive dryness are the use limitations for this association.

Along the West Fork of Tebo Creek the Summit-Newtonia-Snead soil association is found. These are deep to moderately deep soils found mainly in the north central part of the county. Rock outcrops and mounds are common. Native vegetation is warm season tall grasses. Row crops are grown on the more level areas, and grass is grown on steeper slopes. Limitations on this association include erosion problems and drought susceptibility in the thin soil areas.

1.3 Point Sources Located in the Basin

There are no point source discharges that would impact acidity or sulfate in the West Fork, Tributary to Middle Fork and Middle Fork of Tebo Creek.

1.4 History of Basin

Hunters, trappers, and traders arrived in what later became Henry County in the early 1820's. They hunted the abundant wildlife and traded with the local Osage and Shawnee Indians. Settlements were established in the Windsor area in 1831. Schools and churches soon followed. Henry County was first organized under the name of Rives County in 1834, after Senator William Cabell Rives of Virginia (1793-1868). In 1841 the name was changed to honor famed Revolutionary orator and writer Patrick Henry when local Democrats became disenchanted with Rives because of his switch to the Whig Party.

The people of the county were Southern sympathizers during the Civil War. Approximately 500 men signed up with the Confederate Army but only about 50 men took up arms for the

Union. Henry County was a hotbed of unrest during the Civil War. No important battles were fought in the county, but the period was filled with skirmishes between pro-Union groups from Kansas and the local pro-Confederate partisans. Daily life and trade were disrupted. In 1861, Confederate troops wintered in Henry County, but Union soldiers advanced and drove them out. Local officials became alarmed at the Union incursions, and for the duration of the War, county records were removed to Sedalia and stored there. Shortly thereafter, their fears were realized when Col. Jim Lane's troops from Kansas conducted raids in the county and devastated the countryside. After the war, population increased rapidly. Farming and coal production became the county's leading industries.

At the end of the Civil War, people turned to rebuilding the prosperity that was lost during the conflict. Competition between neighboring towns for railroad access became fierce, because towns along the railroads prospered and others declined. In 1867, Henry County contributed $400,000 toward the construction of the Tebo & Neosho Railroad connecting Sedalia, Clinton, and Fort Scott, Kansas. In 1870, the Missouri, Kansas & Texas Railway Co. (MKT or Katy) bought the railroad line. August 23, 1870 marked the coming of the first train into Clinton. Many townspeople had never seen a train before. Fulfilling expectations, the next ten years brought an increase in population of 450 percent. Henry County obtained other railroad connections as the Kansas City & Southern Railroad, (later the Frisco) and Kansas City, Clinton & Springfield Railroad began service in the mid-1880's.

The railroads (1870-1945) distributed nationwide the products of Henry County's local industries, which included coal, pottery, flour, beer and baby chicks. Henry County's Royal Booth developed the first modern hatchery business in the United States in 1913. In the 1920s to 1940s, Booth's company advertised itself as the largest hatchery in the country with over one million eggs in incubation at one time. Henry County remains the site of several hatcheries, recalling the days when Clinton was called "Baby Chick Capital of the World."

Nor was education neglected. Clinton was the site for the Baird College for Young Women, established in 1885. It was considered to be one of "the leading schools for young ladies in the West". It had an average enrollment of 150. It closed in 1899 due to "unforeseen circumstances". It was expected to reopen, but never did.[5]

A turn of the century (1902) encyclopedia account describes Henry County in the typical flowery language of the era as being "perfectly suited for agriculture and also endowed by Nature with extensive clay reserves". Industry included pottery manufacture and tile making. In all, eight potteries were in business during the 19th century until the last one closed in 1910. The county was also known for three large "flouring mills" which ground all the wheat grown in the county. Henry County had a good reputation for its purebred horses and cattle. Even small Henry County towns had at least one newspaper. Clinton had several. In all, 12 newspapers once operated in the county. [6] The Brown Manufacturing Company produced fireworks, and developed a version of Chinese checkers with distribution mainly in the

[5] *Encyclopedia of the History of Missouri,* edited by Howard L. Conrad, published by Southern History Company, of New York, Louisville, and St. Louis, 1901. tacnet.missouri.org/~mgood/history/encycmo.html#BairdCollege
[6] ibid.

Midwest on a seven-year temporary patent. For some reason, the permanent patent never materialized and the game was lost to another company.[7]

The 55,600 acre Harry S Truman Dam and Reservoir on the Osage River was authorized by the federal Flood Control Act of 1954. Originally named Kaysinger Bluff Dam and Reservoir, it was conceived as a flood control project for the Osage River. In 1962, the plans were changed to add hydroelectric power capability and public recreation as purposes for the reservoir. Construction on the dam began on October 3, 1964. It was completed July 21, 1977 and the lake began filling. Normal pool was reached on November 29, 1979. The lake is noted for good crappie, catfish, and bass fishing.

The Katy Railroad discontinued use of its rail between Sedalia in Pettis County and Machens in St. Charles County in August 1986. In 1988, the company merged into the Union Pacific Railroad, and that company donated the rail corridor between Sedalia and Clinton to the Missouri Department of Natural Resources in December 1991 for inclusion in the Katy Trail State Park. The 225 mile State Park provides bicycling, wildlife watching and hiking activities along the Missouri River through some of the most scenic portions of the state.

2.0 Description of the Applicable Water Quality Standards and Numeric Water Quality Targets

2.1 Beneficial Uses

The West Fork, Tributary to Middle Fork and Middle Fork Tebo Creeks have the following Beneficial Uses assigned to them:
- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life and Human Health [associated with] Fish Consumption

2.2 Anti-degradation Policy

Missouri's Water Quality Standards include the Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier I defines baseline conditions for all waters and it requires that existing beneficial uses be protected. TMDLs would normally be based on this tier, assuring that numeric criteria (such as dissolved oxygen and ammonia) are met to protect uses.

Tier II requires that no degradation of high-quality waters occur unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions, rather than the minimal Tier I criteria.

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[7] http://www.blocksite.com/mcsa/mania/MM0797.HTM

Tier III (the most stringent tier) applies to waters designated in the water quality standards as outstanding state and national resource waters; Tier III requires that no degradation under any conditions occurs. Management may prohibit discharge or certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

These TMDLs will result in the protection of existing beneficial uses, which conforms to Missouri's Tier I anti-degradation policy.

2.3 Specific Criteria

pH Standards

Missouri's Water Quality Standards (WQS), 10 CSR20-7.031 Section (4)(E), states that water contaminants shall not cause pH to be outside of the range of 6.5-9.0 SU.

Sulfate Standards

Sulfate and chloride are linked together in the WQS. Section (4)(L)1 concerns streams with 7Q10 low flow of less that one cfs. Here it states that the concentration of chloride plus sulfate shall not exceed 1000 milligrams per liter (mg/L) for protection of aquatic life.

	Impairments
Middle Fork Tebo Creek	5.5 miles sulfate
Tributary to Middle Fork Tebo Creek	1.0 mile pH and sulfate, 1.6 miles sulfate
West Fork Tebo Creek	7.0 miles sulfate

2.3.1 Numeric Water Quality Targets

Numeric Water Quality Target for Sulfate: Sulfate and chloride criteria for the protection of aquatic life are linked in Missouri's Water Quality Standards. Because Tributary to Middle Fork, Middle Fork and West Fork Tebo Creeks each have a 7Q10 low flow of less than one (1) cubic foot per second, the in-stream concentration of chloride plus sulfate in each creek shall not exceed one thousand milligrams per liter (1000 mg/l) at the 7Q10 low flow per 10 CSR 20-7.031(4)(L)1.

Numeric Water Quality Target for pH: pH is the expression of hydrogen ion activity in water and is highly dependent on chemical reactions that consume or produce hydrogen ions. In natural waters these chemical reactions determine the assimilative "buffering" capacity of the solution to neutralize additional acidity or alkalinity. Therefore for TMDL loading purposes, an alkalinity target is also being required to ensure the pH will not be below 6.5 SU in Tributary to Middle Fork Tebo Creek.

As discussed in the Margin of Safety (Section 4.0), the pH criterion alone may not provide sufficient assurance that the proper pH range will be maintained in Tributary to Middle Fork Creek. This is due to possible latent acidity. Net alkalinity is the preferred secondary water quality target because it may be treated as a conservative constituent. However, the lack of acidity data for the site makes a statistical analysis of net alkalinity difficult. Review of data from these sites suggests that total acidity will not be significant at higher total alkalinity values. Thus, total alkalinity is a good approximation of net alkalinity at the Tebos. For this reason, total alkalinity will be used as the secondary numeric water quality target. To assure that the pH water quality standard is met and maintained in Tributary to Middle Fork Tebo Creek, Missouri calculates the total alkalinity target to be 35.0 mg/L or greater year round.

3.0 Loading Capacity – Linking Water Quality and Pollutant Sources
The Loading Capacity (LC) is the greatest amount of pollutant loading that a stream can assimilate without becoming impaired. It is equal to the sum of the Load Allocation (LA), the Wasteload Allocation (WLA) and the Margin of Safety (MOS) and can be expressed as an equation:

$$\mathbf{LC = LA + WLA + MOS}$$

Dry weather design flow from the Tebo Creek AML can not be accurately determined because surface flow and seepage rates from this area are variable. The Tebo Creeks are Class C streams, which cease to flow in dry periods but maintain permanent pools that support aquatic life. Dry weather design flow is therefore 0.1 cfs or less. Since there can be minimal upstream dilution during dry weather conditions, the flow of water coming from the Tebo Creeks AML areas will have to meet in-stream water quality standards for pH (6.5-9.0 SU) and an alkalinity of 35.0 mg/L or more. The pH and alkalinity concentrations used as the TMDL endpoints can not be summed as Load Allocations (LAs) + Wasteload Allocations (WLAs) + Margin of Safety (MOS). The standard Load Capacity equation shown above is not applicable when calculating concentration based endpoints.

pH
For pH as expressed as the concentration in the abandoned mine drainage, the concentration-equivalent load capacity is a pH of 6.5-9.0 SU (the state water quality standard) and a total alkalinity of 35 mg/L or more. To ensure that the pH water quality standard is met and maintained in Tributary to Middle Fork Tebo Creek, the alkalinity target is set at 35.0 mg/L or greater year round.

Sulfate
For sulfate, load capacity is the combined sulfate plus chloride standard of 1000 mg/L. Using the numeric water quality target and margin of safety, an in-stream sulfate plus chloride target of 970 mg/L should ensure that water quality standards are met and maintained in Middle Fork, Tributary to Middle Fork and West Fork of Tebo Creeks. A margin of safety of 30 mg/L or three percent (3%) would ensure combined sulfate and chloride totals on Middle Fork, Tributary to Middle Fork and West Fork of Tebo Creeks would remain below 1000 mg/L

3.1 Load Allocations (Nonpoint Source Load)
Load Allocation is the maximum allowable amount of pollutant loading that can be assigned to nonpoint sources.

Sulfate
Middle Fork Tebo Creek--Using the numeric water quality target and margin of safety, an in-stream sulfate plus chloride target of 970 mg/L should ensure that water quality standards are met and maintained in Middle Fork Tebo Creek.

Tributary to Middle Fork Tebo Creek--Using the numeric water quality target and margin of safety, an in-stream sulfate plus chloride target of 970 mg/L should ensure that water quality standards are met and maintained in Tributary to Middle Fork Tebo Creek.

West Fork Tebo Creek--Using the numeric water quality target and margin of safety, an in-stream sulfate plus chloride target of 970 mg/L should ensure that water quality standards are met and maintained in West Fork Tebo Creek.

pH

Tributary to Middle Fork Tebo Creek—Since the load capacity for Tributary to Middle Fork Creek is concentration based, discharges to the stream will be required to meet the 35 mg/L alkalinity target. This target will allow the standard of 6.5 to 9.0 SU be met.

3.2 Wasteload Allocation (Point Source Load)

The Wasteload Allocation is the maximum allowable amount of the pollutant that can be assigned to point sources. There are presently no point sources discharging to the affected segments of West and Middle Forks Tebo Creeks and Tributary to Middle Fork Tebo Creek. Any future discharges would be required by Missouri State Operating Permit (per the EPA NPDES permit) to maintain a pH in the range of 6.5 – 9.0 SU and concentration of chloride plus sulfate should be 970 mg/L and a secondary requirement for a total alkalinity of 35 mg/L.

4.0 Margin of Safety

Insufficient sulfate, chloride, and other data exist to establish an uncertainty for the linkage between a sulfate plus chloride allocation and water quality in Middle Fork, Tributary to Middle Fork, and West Fork Tebo Creeks. As a result, a margin of safety (MOS) equal to a percent reduction of the loading capacity will be used. If future in-stream monitoring indicates applicable water quality standards are exceeded, the TMDL will be reopened and the MOS re-evaluated based on additional data.

4.1 Middle Fork Tebo Creek

Using the mean chloride concentration found in Middle Fork Tebo Creek (6 mg/L), a conservative in-stream allocation for chloride of one percent (10 mg/L) is appropriate. No other significant sulfate plus chloride sources exist within the watershed, therefore a two percent (2%) allocation to account for these uncertainties is reasonable. A margin of safety equal to a three percent (3%) reduction of the loading capacity (0.03*1000 = 30) has been selected. With a MOS of 30 mg/L ($S0_4$ + Cl), the in-stream S04 + Cl target = 970 mg/L. If future in-stream monitoring indicates applicable water quality standards are exceeded, the TMDL will be reopened and the MOS re-evaluated based on additional data.

4.2 Tributary to Middle Fork Tebo Creek

Tributary to Middle Fork Tebo Creek has two impairments: pH and sulfate.

4.2.1 pH

The pH criterion alone may not provide sufficient assurance that the proper pH range will be maintained in Tributary to Middle Fork Tebo Creek due to possible latent acidity. Net alkalinity would be the preferred secondary water quality target, but the lack of sufficient acidity data make this analysis difficult. As a result, in-stream alkalinity will be used as the secondary water quality target. Alkalinity is a measurable characteristic in Tributary Middle Fork Tebo Creek and can be linked to the pH water quality criterion. Alkalinity has units of mg/L as $CaCO_3$ (calcium carbonate) as discussed in Standard Methods for the Examination of Water and Wastewater.

An Ordinary Least Squares (OLS) approach was used to calculate a regression line and associated statistics for Tributary to Middle Fork Tebo Creek pH and alkalinity values found in Appendix C. Alkalinity standard residuals were computed, plotted and examined for outliers. Data with standard residual values greater than ± 3.0 were considered outliers and not included in the analysis. Residuals were also tested for normality and found to adhere to a normal distribution. The predicted alkalinity associated with a pH of 6.5, with a confidence interval of 95 percent, would be 1.3 mg/L alkalinity ± 33.7 mg/L alkalinity. Choosing the upper confidence limit of +33.7 mg/L alkalinity as the margin of safety, an in-stream target of 35.0 mg/L alkalinity (1.3 mg/L + 33.7 mg/L) should ensure adequate buffering to prevent in-stream pH values from dropping below 6.5.

4.2.2 Sulfate

Using the mean chloride concentration found in Tributary to Middle Fork Tebo Creek (6.3 mg/L), a conservative in-stream allocation for chloride of one percent (10 mg/L) is appropriate. No other significant sulfate plus chloride sources exist within the watershed, therefore a two percent allocation to account for these uncertainties is reasonable. A margin of safety equal to a three percent reduction or 30 mg/L (SO_4 + Cl) of the loading capacity has been selected. If future in-stream monitoring indicates applicable water quality standards are exceeded, the TMDL will be reopened and the MOS re-evaluated based on additional data.

4.3 West Fork Tebo Creek

Using the mean chloride concentration found in West Fork Tebo Creek (7.5 mg/L), a conservative in-stream allocation for chloride of one percent (10 mg/L) is appropriate. No other significant sulfate plus chloride sources exist within the watershed, therefore a two percent allocation to account for these uncertainties is reasonable. A margin of safety equal to a three percent reduction of the loading capacity (0.03*1000 = 30) has been selected. If future in-stream monitoring indicates applicable water quality loading capacity has been selected. With a MOS of 30 mg/L ($S0_4$ + Cl), the in-stream $S0_4$ + Cl target = 970 mg/L. If future in-stream monitoring indicates applicable water quality standards are exceeded, the TMDL will be reopened and the MOS re-evaluated based on additional data.

5.0 Seasonal Variation

The water quality data collected to this point represents all seasons. The primary processes involved in the formation of acid water and the oxidation of sulfide are not significantly affected by differences in air and water temperatures associated with seasonal change. Missouri standards do not distinguish between summer and winter for sulfate and pH.

6.0 Continuous Monitoring Plan Developed Under the Phased Approach
The following is a proposed schedule for monitoring the Tebo Creeks for a variety of stated parameters.

Organi-zation	Monitoring Type	Waterbody Name	F	Fl	N	Mi	Comments
MDNR	Ambient (ESP)	M. Tebo Cr.@ Hwy 2-Henry Co.	4	4	4	4	Plus Flow
MDNR	Ambient (KCRO)	E. Tebo@ Hwy Y, E14,43N,24W	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)
MDNR	Ambient (KCRO)	M. Tebo Cr. NWNW 7,43N,24W	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)
MDNR	Ambient (KCRO)	M. Tebo Cr. SE 7,43N,24W	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)
MDNR	Ambient (KCRO)	M. Tebo Cr. NE19,43N,24W	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)
MDNR	Ambient (KCRO)	E. Tebo Cr. @ Hwy 2-Henry Co.	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)
MDNR	Ambient (KCRO)	E. Tebo Cr. NENW35,44N,24W	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)
MDNR	Ambient (KCRO)	M. Tebo center Sec.25,44N,25W	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)
MDNR	Ambient (KCRO)	M. Tebo Cr. @ Hwy 2-Henry Co.	4	4		4	Chloride, Sulfate, Alkalinity/acidity, Flow (KCRO)

Either the Environmental Services Program (ESP) or the Kansas City Regional Office (KCRO) staff will be doing this monitoring **annually**. The headings are defined as follows:

F – Frequency, how many times monitoring will be done.
Fl – Field Measurements. These include measurements made in the field and include water temperature, pH and specific conductance. For some waters, dissolved oxygen is also measured.
N – Nutrients. These include chemical analysis for nitrite plus nitrate nitrogen, ammonia nitrogen, total kjeldahl nitrogen and total phosphorus.
Mi -- Major ions and allied measurements. These include chemical analysis for calcium, magnesium, sulfate, chloride and bicarbonate and determination of alkalinity/acidity.

Because certain organisms found in a stream can indicate the water quality of that stream, a biological study will be conducted to assess macroinvertebrate diversity.

6.0 Reasonable Assurance

The department's Water Pollution Control Program will continue low-flow water chemical monitoring of the impaired segments of the Tebo Creek system. Periodic review of the department's Water Quality Management Plans and monitoring data should provide reasonable assurance that Middle Fork, Tributary to Middle Fork and West Fork of Tebo Creek will meet water quality standards.

7.0 Implementation Plans

Prior reclamation projects in the Middle and East Tebo Creek alone have cost $4.6 million. It is possible that more wetland cells could be constructed to treat underground water seeps, as has been done in the Middle Tebo Creek area and other abandoned mine land sites around the state. These projects are very expensive, however, and wetland cells would have to be constructed in many locations to handle acidic underground flows. Implementation of any further reclamation work will be addressed as future technology advances are made and program funding allows.

The alkalinity vs. pH regression model will be rerun in 2006 with the new data collected in 2004 and 2005 to determine whether the trend is toward meeting water quality goals. This TMDL will be incorporated into Missouri's Water Quality Management Plan.

8.0 Public Participation

The water quality limited segments of West Fork, Middle Fork and Tributary to Middle Fork of Tebo Creeks are included on the approved 1998 303(d) list for Missouri. The Missouri Department of Natural Resources, Division of Environmental Quality, Water Pollution Control Program developed these TMDLs. Six public meetings to allow input from the public on impaired waters were held between August 18 and September 22, 1999. No comments pertaining to West, and Middle Fork Tebo Creeks or Tributary to Middle Fork Creek were received during the public meetings. A presentation on the Tebo Creeks TMDL was given April 7, 2002 to the Henry County Soil Conservation District Board. In this meeting general facts about the Clean Water Act, the TMDL component of the Act, and the purpose of the Tebo Creek TMDL were explained.

This TMDL was put on 30 day Public Notice from October 24 through November 23, 2003.

9.0 Administrative Record and Supporting Documentation:

An administrative record on the Tebo Creeks TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes the following:

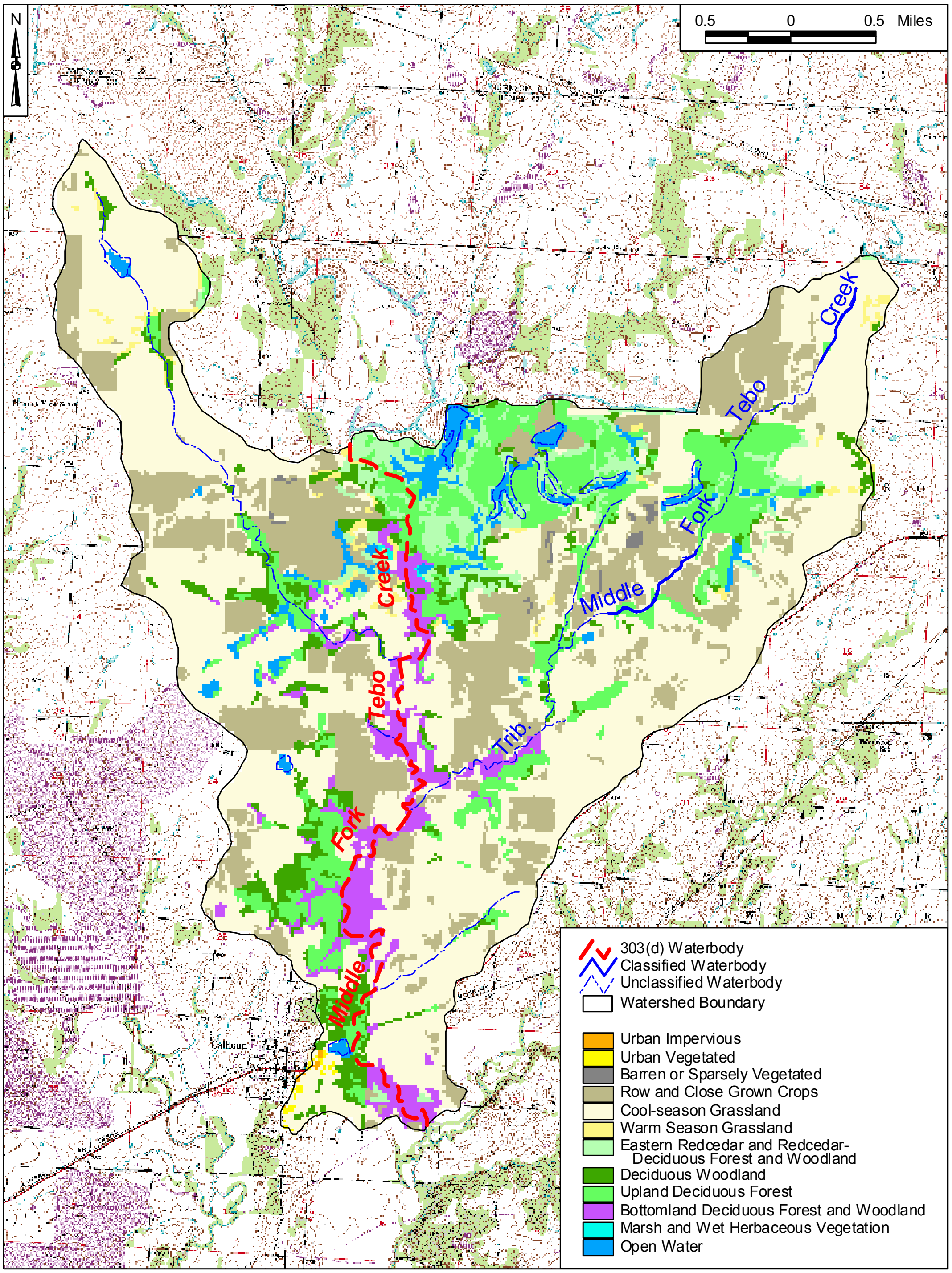
- Middle Fork, Tributary to Middle Fork and West Fork Tebo Creek data
- Public notice announcement
- Tebo Creeks Information Sheet

Basin Water Quality Studies

- Evaluation of the Recovery of Fish and Invertebrate Communities Following Reclamation of a Watershed Impacted by an Abandoned Coal Surface Mine. By James F. Fairchild, Barry C. Poulton, Thomas W. May, and Stuart M. Miller, http://toxics.usgs.gov/pubs/wri99-4018/Volume1/sectionD/1501_Fairchild/pdf/1501_Fairchild.pdf

- Office of Surface Mining Annual Evaluation Summary Report for the Regulatory and Abandoned Mined Land Programs Administered by the Land Reclamation Program of Missouri for Evaluation Year 1998 (October 1, 1997 to September 30, 1998) November 1998 http://www.osmre.gov/missouri98.htm

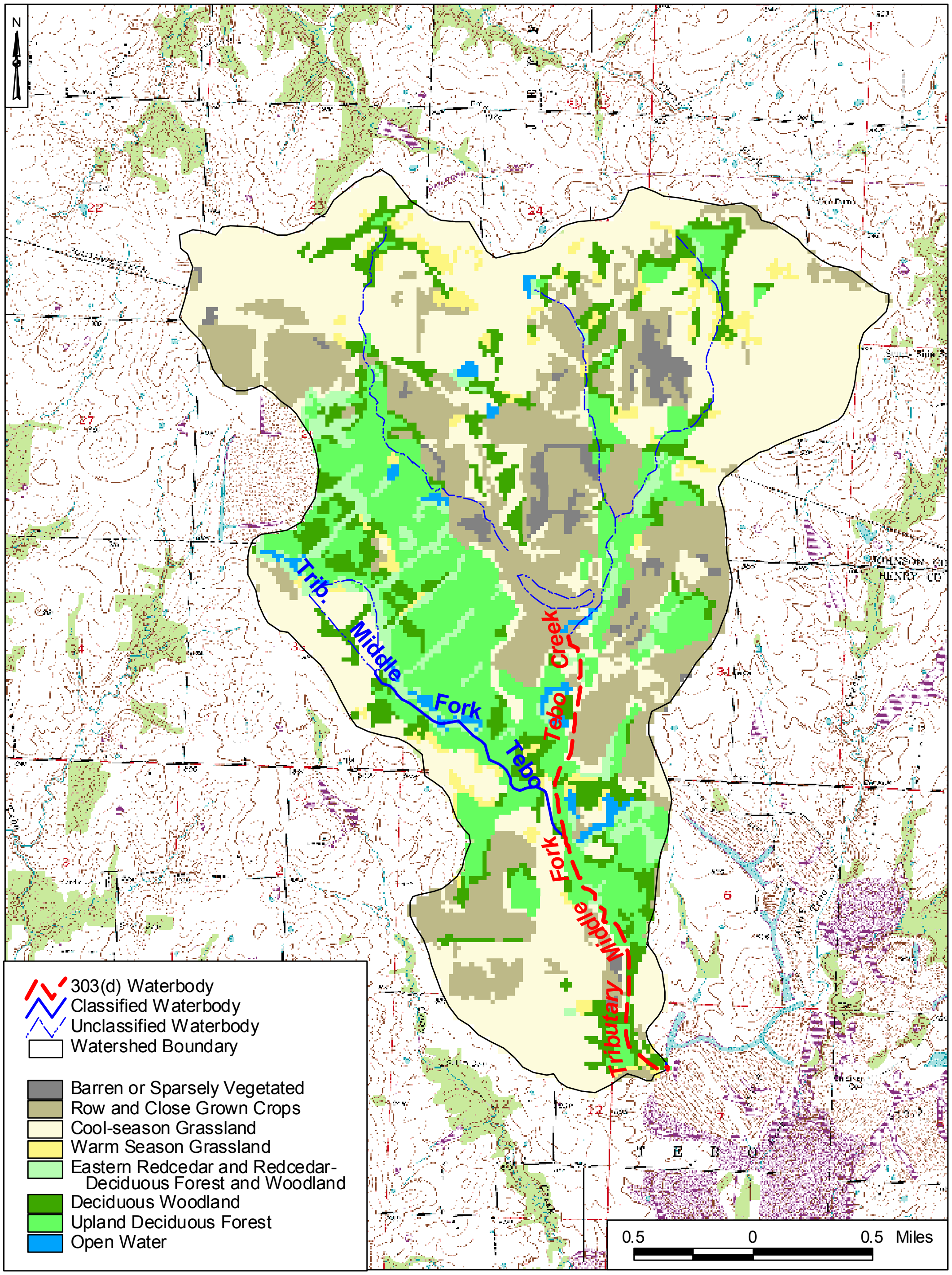
Appendix A
Land Use
Middle Fork Tebo Creek, Henry County, Missouri



Land Uses for Middle Fork of Tebo Creek

Land Use Type	Acres
Urban Impervious	3.34
Urban Vegetated	10.67
Barren or Sparsely Vegetated	23.57
Row and Close Grown Crops	1994.37
Cool-season Grassland	4498.89
Warm Season Grassland	87.84
Eastern Redcedar and Redcedar-Deciduous Forest/Woodland	383.17
Deciduous Woodland	465.68
Upland Deciduous Forest	1139.96
Bottomland Deciduous Forest and Woodland	451.45
Marsh and Wet Herbaceous Vegetation	4.23
Open Water	242.40

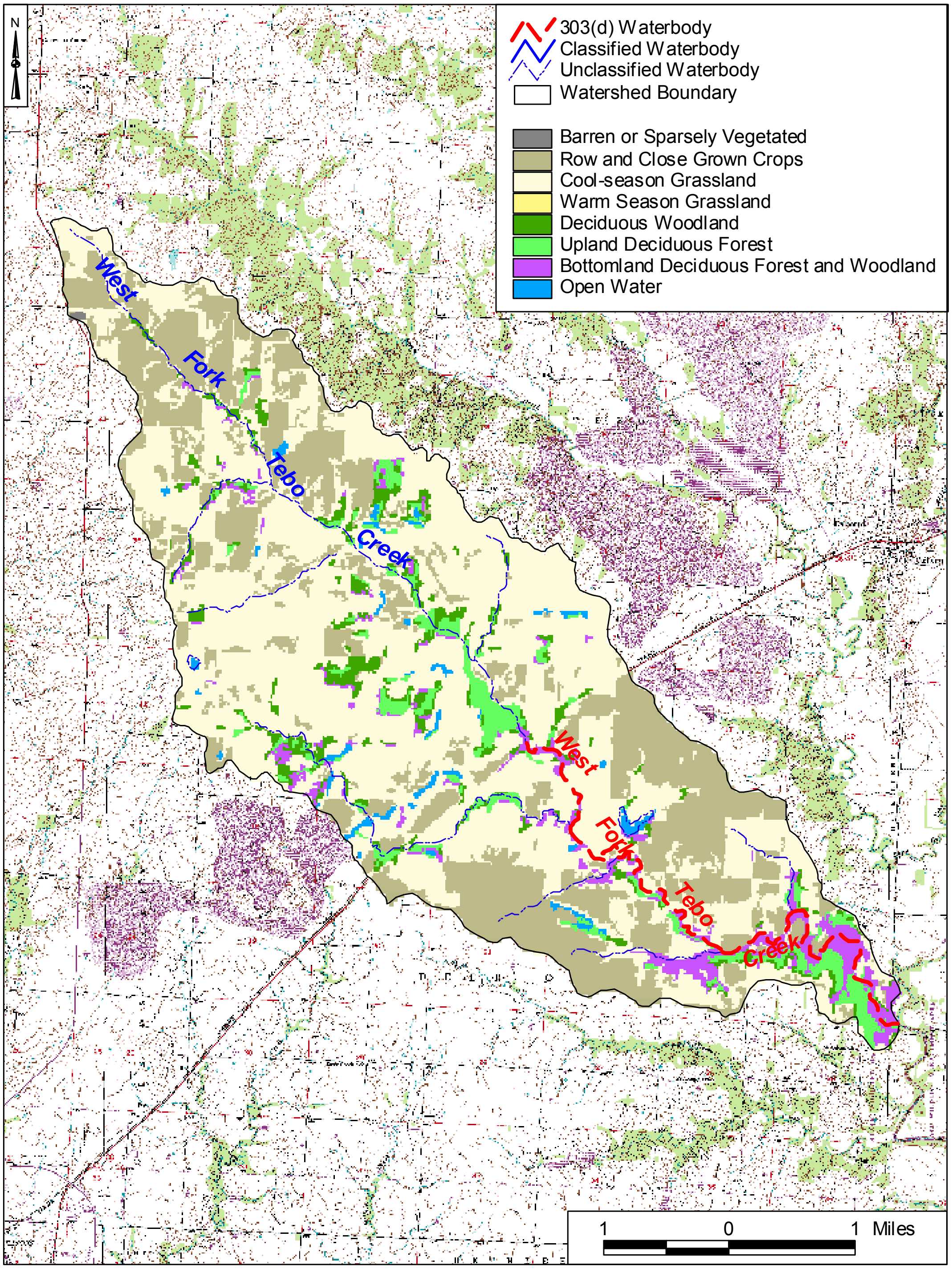
Tributary to Middle Fork of Tebo Creek, Henry County, Missouri



Land Uses for Tributary to Middle Fork of Tebo Creek

Land Use Type	Acres
Barren or Sparsely Vegetated	95.18
Row and Close Grown Crops	1016.53
Cool-season Grassland	1742.85
Warm Season Grassland	132.77
Eastern Redcedar and Redcedar-Deciduous Forest/Woodland	196.59
Deciduous Woodland	414.31
Upland Deciduous Forest	764.12
Open Water	47.15

West Fork of Tebo Creek, Henry County, Missouri

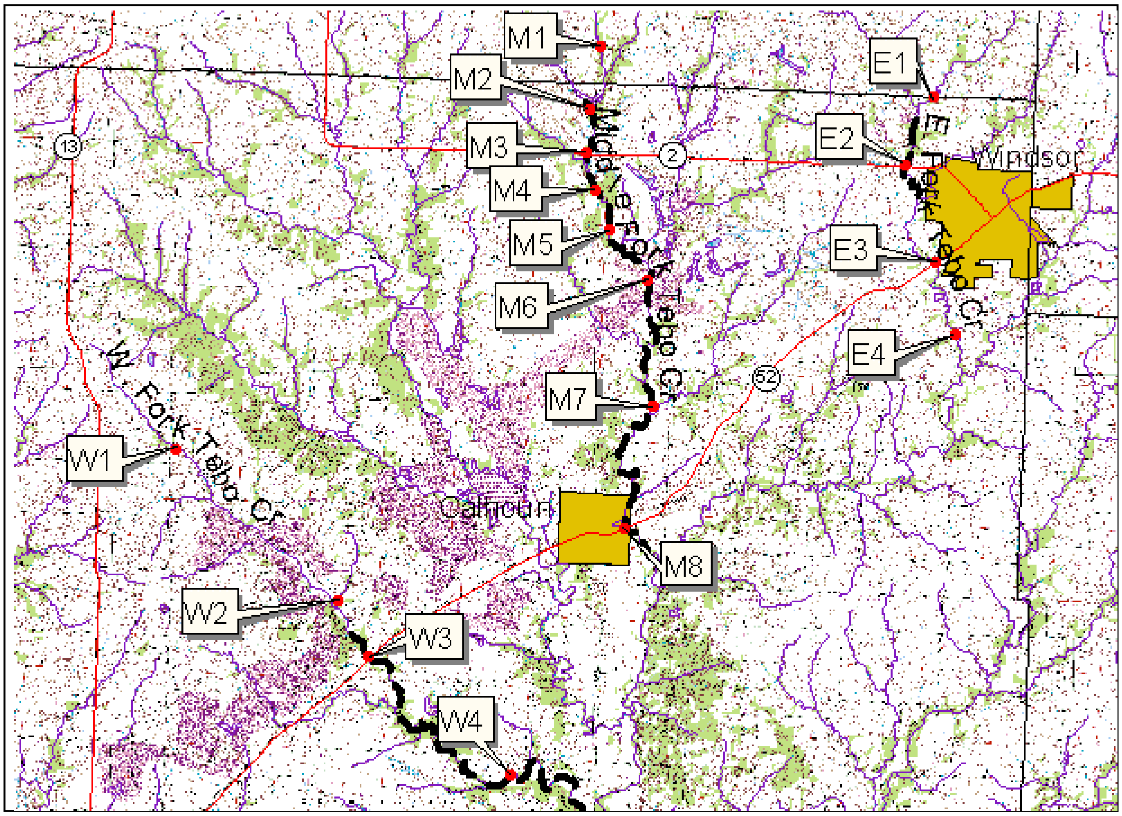


Land Uses for West Fork of Tebo Creek

Land Use Type	Acres
Barren or Sparsely Vegetated	5.34
Row and Close Grown Crops	3900.00
Cool-season Grassland	7119.50
Warm Season Grassland	1.11
Deciduous Woodland	539.07
Upland Deciduous Forest	574.20
Bottomland Deciduous Forest and Woodland	549.30
Open Water	144.33

Appendix B

Map of Impaired Portion of East, Middle and West Tebo Creeks Showing Location of Sampling Sites



Impaired segments

Sample Site Index
E1 – East Fork Tebo Creek 0.5 mile above Triple AML
E2 – East Fork Tebo Creek 0.5 mile below Triple AML
E3 – East Fork Tebo Creek 2 miles below Triple AML
E4 – East Fork Tebo Creek 3 miles below Triple AML
M1 – Tributary to Middle Fork Tebo Creek 0.1 mile above AML
M2 – Tributary to Middle Fork Tebo Creek within AML
M3 – Tributary to Middle Fork Tebo Creek 0.1 mile below AML
M4 – Tributary to Middle Fork Tebo Creek at Highway 2
M5 – Tributary to Middle Fork Tebo Creek 1.2 miles below AML
M6 – Middle Fork Tebo Creek 2 miles below AML
M7 – Middle Fork Tebo Creek 4 miles below AML
M8 – Middle Fork Tebo Creek at Highway 52
W1 – Tributary to West Fork Tebo Creek
W2 – Tributary to West Fork Tebo Creek
W3 – West Fork Tebo Creek at Highway 52
W4 – West Fork Tebo Creek at County Road

Appendix C
Data

Middle Fork of Tebo Creek

Table 3. Middle Fork Tebo Creek Post-Reclamation Data

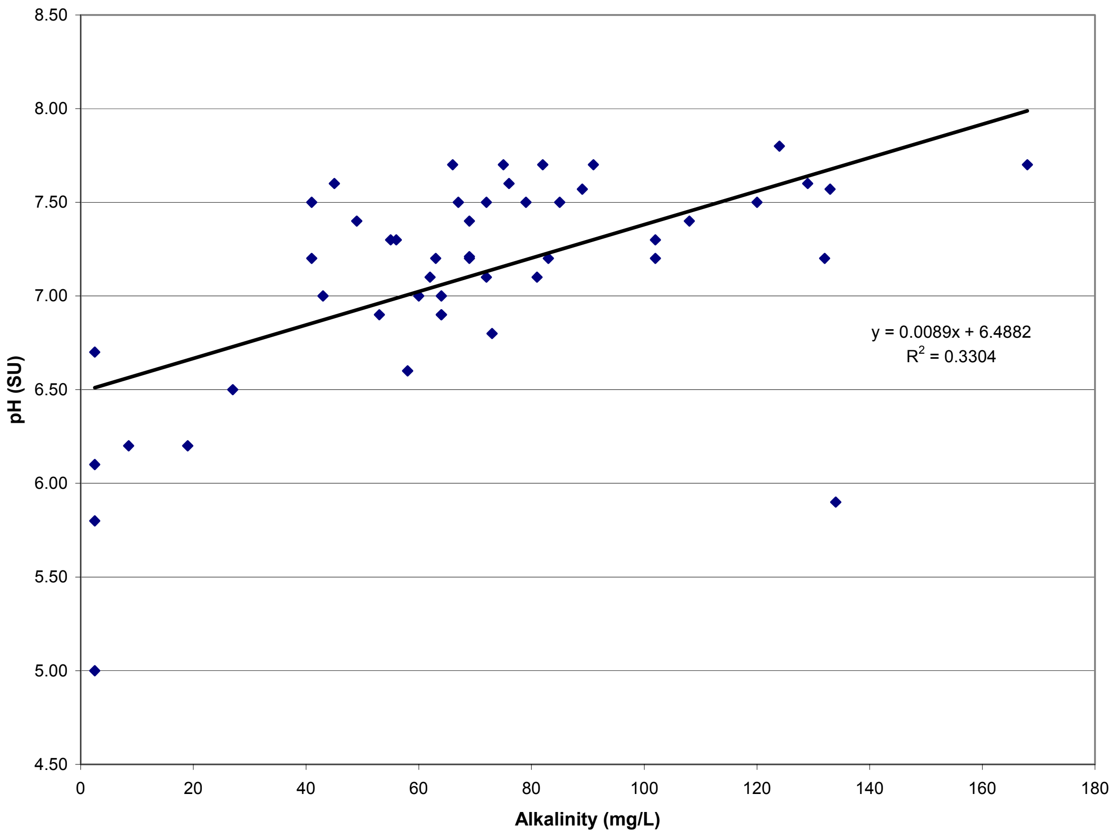
Site	Site Name	Yr	Mo	Dy	PH	SC	Alk	Acid	SO4	Cl	SO4 + CL
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2000	3	21	7.4	979	79		424	7	431
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2000	3	21	7.4	979	79		424	7	431
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2000	6	15	7.5	890	73		372	6	378
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2000	9	21	7.1	1300	123		585	5	590
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2001	4	26	7.4	1340	104	2.499	618	6	624
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2001	6	13	7.4	1420	102	2.499	650	4.99	655
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2001	8	14	7.8	930	129	2.499	930	8	938
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2001	8	16	7.4	1950	118	2.499	1080	2.499	1082
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2001	9	6	7.3	2270	114	2.499	1310	5	1315
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2001	10	3	7.2	2090	114	2.499	1070	5	1075
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2001	11	30	7.4	1870	110	2.499	940	7	947
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2002	1	10	7.4	2220	111	2.499	1090	7	1097
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2002	3	14	7.8	1430	93	2.499	940	11	951
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2002	6	6	7.7	1360	105	2.499	728	5.75	734
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2002	6	20	7.8	1090	110	2.499	481	5	486
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2002	10	2	7.7	1330	181	2.499	595	2.499	597
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	2002	11	20	6.7	2600	108	2.499	1490	7	1497
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	1997	7	30	7.4	2510	148		1380	2.499	1382
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2000	3	21	7.6	1110	89		479	6.9	486
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2000	6	15	7.3	1010	73		447	5	452
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2000	9	21	7	1900	171		941	2.499	943
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2001	6	13	7.4	1720	116	2.499	797	4.99	802
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2001	8	14	7.9	2170	144	2.499	1120	7	1127
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2001	8	16	7.4	2300	138	2.499	1350	2.499	1352
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2001	9	6	7.3	2290	140	2.499	1300	8	1308
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2001	10	3	7.4	2160	161	2.499	1080	5	1085
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2001	11	30	7.5	2280	118	2.499	1260	7	1267
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2002	1	10	7.3	2780	135	2.499	1470	8	1478
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2002	3	14	7.8	1328	100	2.499	1140	10	1150
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2002	6	6	7.6	1530	116	2.499	833	5.51	839
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2002	6	20	7.7	1300	121	2.499	601	6	607
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2002	10	2	7.4	2080	149	2.499	1180	6	1186
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	2002	11	20	6.9	2790	113	2.499	1650	8	1658

Note: Values of 2.499 represent a lab reported value of "less than 5" as the analysis result

Site	Site Name	WBID	CLS	Latitude	Longitude	Description
1284/3.5	M. Fk. Tebo Cr. 4 mi.bl. AML	1284	C	38.4932	-93.6106	M. Fk. Tebo Cr. NE Sec.19, 43N,24W
1284/5.8	M. Fk. Tebo Cr. 2 mi.bl. AML	1284	C	38.5187	-93.6117	M. Fk. Tebo Cr. SE Sec. 7, 43N,24W

Tributary to Middle Fork of Tebo Creek

Figure 1. Relationship between pH and Alkalinity in Tributary Middle Fork Tebo Creek, Henry County, Missouri



Regression Analysis

Mean pH	7.113
Mean Alkalinity	70.051
Sum of Squares (x^2 = Alkalinity)	66659.663
Sum of Squares (y^2 = pH)	16.065
Sum of Squares (xy = Alkalinity and pH)	594.852
Pearson Correlation Coefficient	0.575
Regression Slope	0.0089
Mean Square Error	0.229
Standard Error of the Regression	0.478

Regression Statistics	
Multiple R	0.57482153
R Square	0.33041979
Adjusted R Square	0.3161734
Standard Error	0.47840586
Observations	49

Ordinary Least Squares (OLS) Analysis
Tributary Middle Fork Tebo Creek, Henry County, Missouri

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.308285666	5.308285666	23.1932	1.56298E-05
Residual	47	10.75699189	0.228872168		
Total	48	16.06527755			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	6.48815084	0.146694331	44.22904974	5.9E-40	6.193040194	6.7832615
X Variable 1	0.00892371	0.001852955	4.815935388	1.6E-05	0.005196051	0.0126514

Figure 2. Alkalinity Residual Plot for OLS Analysis,
Tributary Middle Fork Tebo Creek, Henry County, Missouri

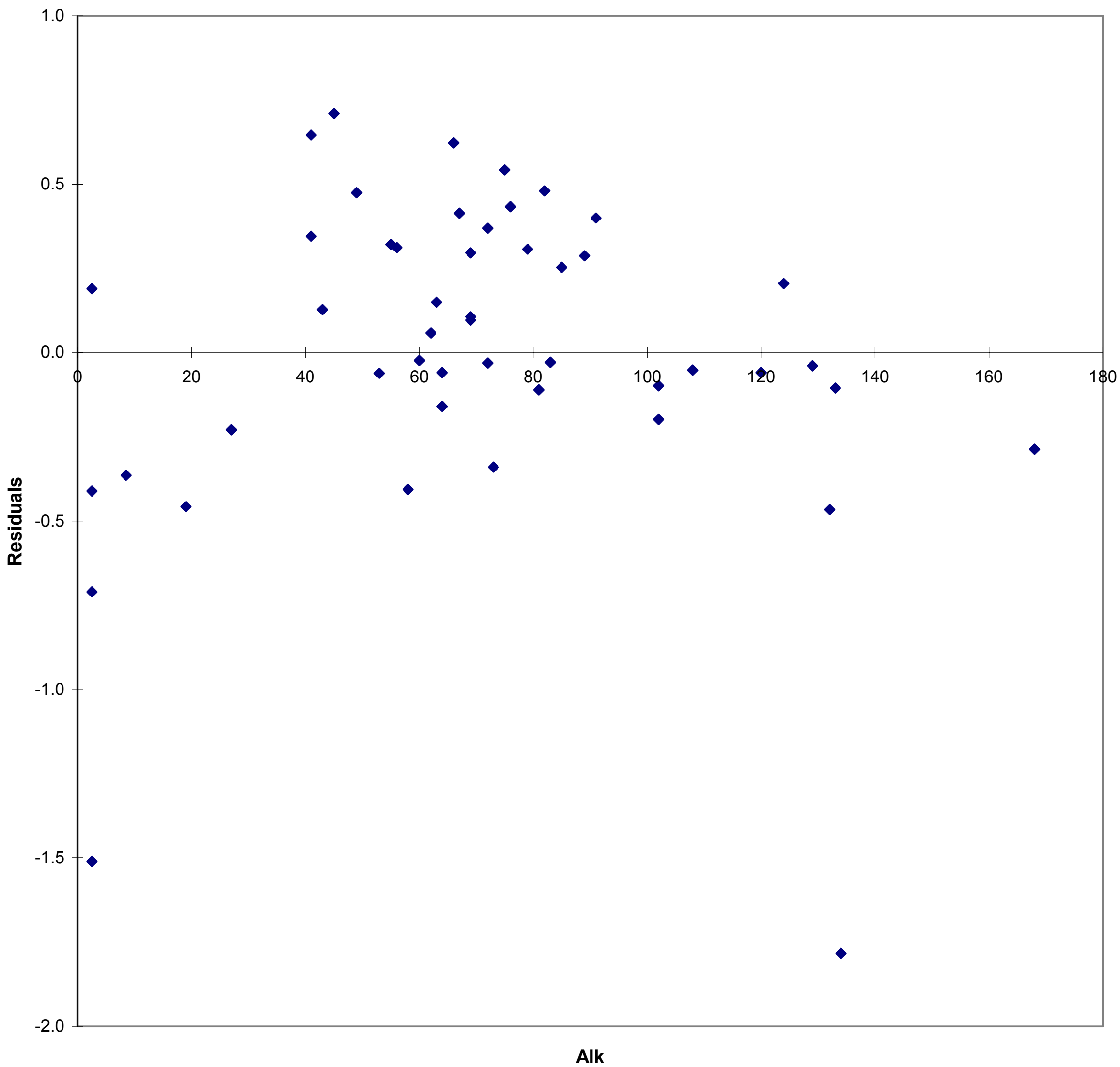


Figure 3. Normality Plot for Tributary Middle Fork Tebo Creek, Henry County, Missouri

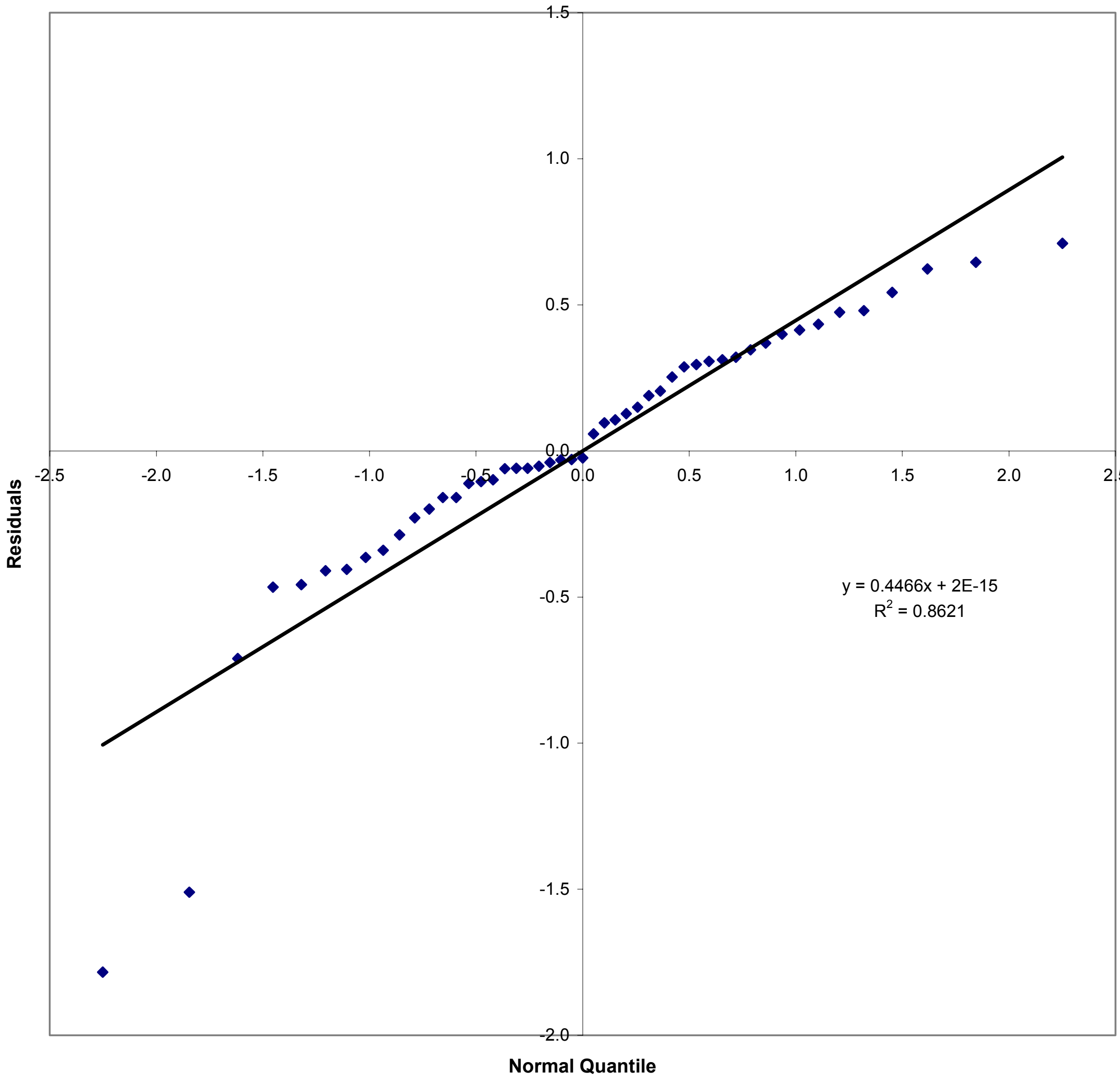


Table 4. Tributary Middle Fork Tebo Creek Post-Reclamation Data

Site	Site Name	Yr	Mo	Dy	pH	SC	Alk	Acid	SO4	Cl	SO4 + Cl
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	1997	7	2	7.40	2350	108		1410	0.99	1411
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	1998	4	21	7.50	1910	120		944	6	950
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	1998	8	11	7.70	2200	75		1480		1480
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	1998	9	3	7.50	2005	67		1340		1340
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2000	3	21	7.50	1410	72		661	6	667
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2000	6	15	7.40	1530	69		742	5	747
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2000	9	21	6.90	2120	64		1220	7	1227
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	4	26	7.50	2050	79	2.499	1130	6	1136
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	6	13	7.30	2500	102	2.499	1450	4.99	1455
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	8	14	7.70	3130	82	2.499	1920	7	1927
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	8	16	7.50	3270	85	2.499	2260	2.499	2262
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	9	6	7.10	3130	72	2.499	2030	8	2038
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	10	3	7.30	2950	56	2.499	1750	8	1758
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	11	27	7.50	3070	41	2.499	1930	8.31	1938
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2001	11	30	7.60	3050	45	2.499	1920	9	1929
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2002	1	10	7.00	3550	64	2.499	2110	10	2120
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2002	3	14	7.60	1857	76	2.499	1790	9	1799
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2002	6	6	7.57	1040	89	2.499	1300	5.63	1306
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2002	6	20	7.70	1720	91	2.499	983	6	989
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	2002	10	2	7.70	3330	66	2.499	2270	10	2280
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1997	7	2	6.80	2380	73		1300	0.99	1301
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1997	7	30	6.90	3550	53		1380	5	1385
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1998	4	21	7.20	1730	102		845	5	850
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1998	8	11	7.70	425	168		58		58
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1998	8	11	7.20	2230	41		1530		1530
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1998	9	3		590	139		122		122
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1998	9	3	7.00	1465	43		829		829
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1999	4	7	7.30	1232			618	8	626
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	1999	7	21	6.60	2900	58		1860	6	1866
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2000	3	9	7.60	1110	129		424	7	431
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2000	3	21	7.10	1160	62		533	6	539
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2000	6	15	7.20	1130	63		544	2.499	546
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2000	6	20	7.40	961	49	0	475	2.499	477
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2000	9	11	3.60	3500	0	358	2280	6	2286
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2000	9	21	3.70	3700			2450	7	2457
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	3	7	6.90	1320	64	2.499	652	7	659
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	4	26	7.00	2020	60	2.499	1150	2.499	1152
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	6	13	7.20	2140	83	2.499	1220	4.99	1225
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	6	26	7.10	1830	81	2.499	975	4.99	980
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	8	14	6.50	3090	27	18	1950	2.499	1952
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	8	16	6.20	3240	19	28	2350	2.499	2352
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	9	6	5.80	2960	2.499	2.499	1960	8	1968
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	9	7	7.20	1060	132	2.499	453	2.499	455
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	10	3	5.00	2990	2.499	59	1850	8	1858
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	11	27	6.20	3160	8.5	39	2120	9.44	2129
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	11	30	6.70	3220	2.499	30	2150	13	2163
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2001	12	14	5.90	1120	134	2.499	386	5	391

Site	Site Name	Yr	Mo	Dy	pH	SC	Alk	Acid	SO4	Cl	SO4 + Cl
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2002	1	10	6.10	3530	2.499	34	2320	15	2335
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2002	3	14	7.30	1645	55	2.499	938	10	948
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2002	3	20	7.80	1000	124	2.499	432	7	439
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2002	6	6	7.57	802	133	2.499	292	6.61	299
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2002	6	6	7.21	913	69	2.499	1160	6.09	1166
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2002	6	20	7.20	1380	69	2.499	743	2.499	745
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1mi.bl. AML	2002	10	2	2.80	3330	2.499	232	2550	9	2559
Note: Values of 2.499 represent a lab reported value of “less than 5” as the analysis result											

pH in Standard Units, Alkalinity in mg/L as $CaCO_3$, Specific Conductivity in μmhos/cm, all other analytes in mg/L

Site	Site Name	WBID	CLS	Latitude	Longitude	Description
1288/0.3	Trib. M. Fk. Tebo Cr. 1.2 mi.bl. AML	1288	C	38.5299	-93.6216	Trib. M. Fk. Tebo Cr. NW Sec. 7, 43N, 24W
1288/1.5	Trib. M. Fk. Tebo Cr. 0.1 mi.bl. AML	1288	C	38.5187	-93.6117	Trib. M Fk. Tebo Cr. @ Hwy 2, SE Sec. 36, 44N, 25W

West Fork Tebo Creek

Table 5. West Fork Tebo Creek Water Quality Data

Site	Site Name	Yr	Mo	Dy	PH	SC	Alk	Acid	SO4	CL	SO4 + CL
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	1999	4	7	8.1	1464			656	11.0	667
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	4	5	7.9	822			328	8.0	336
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	4	26	8.3	1700	181	2.499	795	8.0	803
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	6	13	7.8	1470	179	2.499	611	4.99	616
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	7	24	7.8	1680	185	2.499	873	7.0	880
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	8	14	8.1	1770	191	2.499	802	9.0	811
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	9	5	7.8	683	180	2.499	848	7.0	855
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	10	3	7.7	1856	196	2.499	845	7.0	852
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	11	26	7.8	1680	208	2.499	856	7.72	864
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	11	27	8.2	490	120	2.499	92.6	13.4	106
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2001	11	30	8.1	1960	212	2.499	915	8.0	923
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2002	1	9	8.1	2180	214	2.499	963	8.0	971
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2002	3	13	8.4	1375	146	2.499	630	14.0	644
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2002	6	5	8.1	1680	196	2.499	887	7.5	895
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2002	6	19	7.5	1340	172	2.499	600	8.0	608
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2002	10	2	7.9	1890	169	2.499	1030	8.0	1038
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	2002	11	20	7.3	2250	220	2.499	1140	8.0	1148
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1986	11	7	8.1	2010	228		1200	7.0	1207
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1986	12	2	7.4	690	96		300	7.0	307
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	1	8	7.9	2130	236		1200	4.0	1204
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	2	5	7.9	1580	182		740	6.0	746
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	3	5	7.9	1440	162		700	10.0	710
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	4	9	8.1	1860	196		1000	3.0	1003
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	5	21	8.1	2010	196		1100	8.0	1108
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	6	11	7.9	2130	194		1200	7.0	1207

Site	Site Name	Yr	Mo	Dy	PH	SC	Alk	Acid	SO4	CL	SO4 + CL
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	7	7	8.0	1850	170		960	6.0	966
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	8	6	7.7	2020	159		1100	6.0	1106
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	9	3	8.0	2370	166		1200	6.0	1206
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	11	5	7.9	2230	220		1300	7.1	1307
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1987	12	8	8.0	2450	222		1200	6.9	1207
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	1	6	7.9	2020	214		1200	26.0	1226
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	2	2	8.1	1740	184		880	6.5	887
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	3	1	8.1	1860	193		890	7.4	897
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	4	7	7.9	1560	176		830	4.4	834
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	5	10	8.1	2110	222		1200	6.4	1206
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	6	14	8.1	1970	211		1300	3.4	1303
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	7	12	8.0	2060	176		1200	5.4	1205
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	8	4	7.8	1840	140		1100	4.9	1105
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	9	6	8.0	1520	136		940	5.1	945
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	10	6	7.9	1840	134		1100	5.0	1105
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	11	3	7.8	2140	166		1300	5.0	1305
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1988	12	20	8.3	2170	182		1200	6.0	1206
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	1	5	8.0	2000	166		1200	5.0	1205
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	2	7	7.4	2430	230		1600	5.0	1605
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	3	7	8.1	1640	155		930	6.0	936
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	4	5	8.1	1560	142		840	7.0	847
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	5	11	7.9	2130	181		1300	5.0	1305
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	6	8	7.8	1630	164		860	7.0	867
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	7	19	8.0	2110	188		1300	4.0	1304
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	8	1	7.9	2060	185		1300	4.0	1304
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	9	8	8.0	1960	169		1200	5.0	1205
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	10	13	7.8	2160	196		1300	5.0	1305
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	11	9	8.0	2270	262		1400	5.0	1405
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1989	12	7	8.1	2270	194		1400	4.0	1404
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	1	11	8.0	1890	156		1100	5.0	1105
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	2	8	8.2	1630	160		930	10.0	940
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	3	8	8.1	1500	147		730	10.0	740
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	4	4	8.3	1610	161		900	7.0	907
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	5	7	8.3	1410	163		870	6.0	876
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	6	7	8.0	1820	225		1000	6.0	1006
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	7	12	7.9	1330	150		560	13.0	573
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	9	6	8.1	2060	228		1200	9.0	1209
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	10	16	8.0	2040	203		1200	23.0	1223
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	11	7	7.8	2080	188		1300	9.0	1309
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1990	12	6	8.0	1920	173		1200	10.0	1210
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	1	9	7.8	2090	218		1300	5.0	1305
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	2	4	7.8	956	107		410	12.0	422
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	3	6	8.0	1860	188		1300	9.0	1309
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	4	17	7.9	2010	198		1400	4.0	1404
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	5	7	7.8	1390	147		740	8.0	748
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	6	4	8.0	1770	197		1000	7.0	1007
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	7	18	8.0	2040	161		1200	7.0	1207

Site	Site Name	Yr	Mo	Dy	PH	SC	Alk	Acid	SO4	CL	SO4 + CL
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	8	12	8.0	2020	162		1300	10.0	1310
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1991	9	6	7.6	2040	144		1300	12.0	1312
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	2003	4	23	7.8	1745	167	2.499	929	13.0	942
1292/5.6/1.2	W. Fk. Tebo Cr. @ Hwy 52	1997	7	30	7.0	2410	116		1360	2.499	1362
1292/5.6/1.2	W. Fk. Tebo Cr. @ Hwy 52	2001	6	13	7.9	1850	252	2.499	811	4.99	816
Note: Values of 2.499 represent a lab reported value of “less than 5” as the analysis result											

Site	Site Name	WBID	CSL	Latitude	Longitude	Description
1292/1.8	W. Fk Tebo Cr. At Cnty Rd.	1292	C	38.41670	-93.64730	NE Sec. 23, 42N, 25W
1292/4.0	W. Fk. Tebo Cr. Nr. Lewis	1292	C	38.42150	-93.66080	NW NW NW Sec. 23, 42N, 25W (USGS 06922190)
1292/5.6/1.2	W. Fk. Tebo at Hwy 52	1292	C	38.44180	-93.68320	SE Sec. 9, 42N, 25W